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Salary Determination in the National Hockey League: Restricted, Unrestricted, Forwards, and Defensemen

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I. Introduction

Through simple comparison of league revenues, the National Hockey League (NHL) is the smallest of the four major American professional sports leagues.[1] While its importance tends to be understated here in the United States, it is also growing at the fastest rate among the top four leagues.[2] The NHL is also enormously popular in Canada, and rivals the popularity football and the NFL enjoy in the States. The lesser popularity of the sport in the United States may explain why there is a huge disparity in the number of studies conducted by American economists on the sport; they are far outnumbered by Canadian economists and statisticians. Whatever the national preference though, the NHL provides a stellar example of a sports labor market, and hence the inspiration for this thesis.

This thesis will attempt to estimate the relationships between salary and measures of the marginal productivity of hockey players, or performance indicators. Salary determination, as in most other sports leagues, is determined in a labor market. Each player has a marginal revenue product of labor (MRP_L) and this MRP_L varies from player to player, and from team to team. Firms, in this case teams, seek to add players with a high MRP_L in order to increase the quantity and quality of product they sell, in this case wins. Among other things, a player has a MRP_L that will equate to the additional revenue and additional productivity they are able to bring in.[3] How do teams, or economists, determine what this is though? Unlike a typical labor market that uses factors such as age, education, experience levels, etc. to determine the corresponding MRP_L, sports leagues are unique in that these characteristics directly taken from easily-tracked performance indicators. These performance indicators will be goals, assists,

plus/minus rating, and career games and will represent the marginal product of labor (MP_L) in the wage equation. In addition to performance indicators, the All-Star variable is a measure of fan preference. This will be used to control for potential differences in marginal revenue that may be added if the player is hired. Past studies have recognized the important differences between forwards and defensemen, to separate these two groups; a dummy has been added as the final variable. However, these past studies have neglected one key factor in analyzing salary determination in the NHL, and that is the difference between restricted and unrestricted free agents.

After the 2004-2005 NHL lockout, a new Collective Bargaining Agreement (CBA) was struck between the NHL and the NHL Players Association (NHLPA). This CBA stipulated that anyone under the age of 27 years old, or having less than seven years of experience in the league would be subject to the league's "restricted free agency" clause. This provides a very tangible difference in the bargaining rights of the individual player, and is predicted to affect the determination of the regression as well. The use of an ordinary least squares (OLS) regression analysis will attempt to show the link between salary and seven important performance indicators; goals, assists, plus/minus rating, career games played, team performance, All-Star appearances and a dummy indicating whether a player is a forward or defenseman.

One important contribution is to examine how the CBA might differently affect the determination of salary between the two groups. One group includes league "veterans" or those players that have the ability to benefit from unrestricted free agency as outlined in the

2005 CBA. This benefit is only granted to those players who have at least seven years of NHL experience or are 27 years old, aptly named the "27-or-7 Rule." This is an important caveat because prior to this qualification, players are considered restricted free agents. This means if the team puts forth a "qualifying offer", the agent can either accept it and the player remains with the same team: alternatively the agent can reject it and the player remains a restricted free agent that no other team NHL can bargain with. This effectively places severe limitations on the bargaining rights of a player, and therefore severely limits his ability to bargain for a higher salary. While he may bargain for a higher salary, he is limited to the steps outlined in the NHL's CBA. For example, if the player is currently making less than $660,000, a qualifying offer need only offer a 10 percent raise, or $66,000. If a player is making from $660,000 to $1,000,000, a qualifying offer is only a 5 percent raise, and players making more than $1,000,000 only have to be offered *at least* their old salary.[4] Such stipulations on restricted agents place them in a different category than unrestricted agents.

To account for this fundamental difference, the sample of 710 players were broken up into two groups; those qualifying for unrestricted free agency and those only qualifying for restricted free agency. I used the same regression model for both groups, with the same variables. While the days of the reserve clause are long past, restricted free agency still provides team owners with an advantage over their players. While this power may seem unfair to restricted free agents, there are backstops to prevent total abuse of these restrictions. It is called salary arbitration, and only applies to restricted free agents. Salary arbitration was designed as a backstop to prevent any abuses of restricted free agents and their salaries. While the limits about qualifying offers are certainly well-laid out, there are certainly players that are

offered more than the salary floor. There are also those that are offered only what the minimums require, and some feel that this is unfair. In these cases, the restricted free agent may request an arbitration hearing. The NHL differs from the other professional leagues in the actual processing of the arbitration hearing. For example, in the MLB, both parties submit evidence justifying their claims *as well as* the salary they feel is deserved. The arbitrator then picks between the two numbers presented by the parties. The NHL, on the other hand, requires both parties submit evidence justifying their opinion, but the arbitrator will make a final decision based off of a number he or she comes up with; the club and the player do not submit a salary they think is fair. Interestingly, in a study conducted by James Lambrinos and Thomas Ashman, "Salary Determination in the National Hockey League is Arbitration Efficient?" found that there was no statistical difference between arbitrated salaries and non-arbitrated salaries.

II. Literature Review

There are two studies that examine salary determination in the NHL. The first study by Claude Vincent and Byron Eastman "Determinants of Pay in the NHL: A Quantile Regression Approach" took salary as a function of performance indicators, such as goals, assists, plus/minus, but they also used physical characteristics of players as well. They use the variables of height and weight to attempt to quantify the elusive "defensive talent" characteristic of all hockey players as a part of salary determination. In terms of experience, they used career games as well, but their expected sign on the variable was negative, not positive. They also used an All-Star variable, but instead of summing total appearances, they simply included it as a dummy variable. They laid the groundwork for a set of variables relevant in an NHL salary

determination study. They were also one of the first to regress forwards and defensemen separately; recognizing important differences in the productivity of each position. Their results were interesting as well. Goals and assists were wrapped up in a "points" variable that combined the two totals, which was significant at the 5 percent level. Plus/minus was insignificant at both the 1 percent and 5 percent levels. Height and weight were also insignificant for both forwards and defensemen. All-Star and career games were both significant at the 5 percent level. The noteworthy result of this study was the result of the plus/minus and the height and weight variables. Vincent and Eastman attempted to account for a characteristic, defensive ability, which is difficult to capture in a regression model. They also were mistaken about the sign of career games. They predicted it to be negative, but it ended up being significant and positive at the 1 percent and 5 percent levels of significance. This is important because it provides the basis for the assumption that more experience in the NHL does indeed lead to higher salary.

The second study by James Lambrinos and Thomas Ashman "Salary Determination in the National Hockey League is Arbitration Efficient?" is informative because it highlights the important differences between unrestricted and restricted free agents. While Lambrinos and Ashman do not separate their sample into restricted and unrestricted free agents, many of the reasons they use to determine whether or not salary arbitration is efficient are applicable to a regression that compares unrestricted and restricted agents. After all, salary arbitration only applies to restricted free agents; unrestricted agents cannot apply for salary arbitration. They also tried to determine the effect that defensive ability has on salary; Lambrinos and Ashman included a plus/minus variable, along with a height and weight variable. All three were found to

be statistically insignificant. They stated that there were examples of arbitrated salaries that were significantly different from the next negotiated salary contract as a free agent. The example they use is that of Bobby Holik, who during the 2001-2002 season received an arbitrated salary of $3.5 million, and the season after when he became an unrestricted free agent, received $7.0 million a year with a $10 million bonus from the Rangers. Their point here is well taken, "Certainly, his marginal revenue product is not likely to be so dramatically different from one season to the next, suggesting that either the arbitrator or the New York Rangers or both were not correctly measuring his true marginal revenue product."[5] Alternatively, this difference in salary has less to do with a miscalculation of his marginal revenue product, but rather an example of the differences between a restricted and unrestricted free agent; immediately after becoming a free agent, Holik doubled his salary, not even including the bonus he received, which make his salary almost five times higher. While Lambrinos and Ashman do a stellar job analyzing the effect of arbitration on salary, they missed a key factor in their analysis of why salaries change when moving from a period of restricted free agency to unrestricted free agency; the simple difference between a restricted and unrestricted free agent.

III. Regression Model

The data used in this study were collected from the NHL statistical archives for the 2011-2012 season. The sample is comprised of 710 players corresponding to all players who appeared in at least 15 of the 82 games in this most recent season. In this regression model, the dependent variable is *salary*, and the independent variables are *goals, assists, plusminus,*

career, team and *offdef.* Some variables are included for fairly apparent reasons; others may be less obvious. When considering the wage equation

$$w = MP_L \times MR$$

both the marginal product factors and marginal revenue factors must be considered. For the team owner the MP_L includes performance indicators like goals, assists, career games (experience), etc. Goals and assists are direct performance offensive indicators. Goals are counted when the player scores on the opposing team's goalie. Assists are handed out for each goal scored. For any goal, there is a range of possible assists possible, from no assists up to two players assisting on the goal. An assist is calculated simply through determining the last two players to touch the puck before the player who scores the goal. Those players will have assists registered to their name. Both are easy to measure and accurately represent a player's offensive capabilities, and provide a fairly direct measure of the player's MP_L. Goals and assists are *both* logged in order to provide elasticities with salary. This is beneficial in an analysis of these variables because a percentage change in goals or assists will correspond with a percentage change in salary. Both goals and assists are summed totals per player during the 2011-2012 season.

The plus/minus rating is included in an effort to capture a player's defensive capabilities, whether he is a forward or a defenseman. A player's plus/minus rating is often used as a measure of a player's defensive abilities regardless of their position. A player is given a "+1" when they are present on the ice when their team scores (whether or not they registered a goal or an assist for the play). A player is given a "-1" when they are present on the ice when the

other team scores against them. As the season progresses, these tallies are summed to present a final plus/minus statistic – this is the figure used in this regression. This variable is also logged in order to capture elasticity, much the same as with goals and assists. In order to log this variable the lowest plus/minus value that was tallied by a player during the 2011-2012 season was adjusted by adding 35, so the lowest data point was raised to 1. This transformation allows the variable to be logged (by eliminating negatives and zeros) without qualitatively changing the significance of the variable. The plus/minus variable is a scale that represents "weak" defensive players at the bottom (negative totals) and "strong" defensive players on the top (positive totals), and this transformation preserves this characteristic.

Career games are a measure of experience, an equivalent measure to "job experience" in a standard wage equation. The coefficient on this term will state the percentage increase in salary as a result of one more career game. What theory has shown is that the more the experience a player has, the higher the salary he commands will be.

The team variable is a summed total of points amassed by a team over the 2011-2012 season. A team receives two points for a win, zero points for a loss, and one point for an overtime loss (if the game is tied at the end of regulation, both teams will receive a point going into overtime, and the winning team will receive an extra point for winning). For example, a team with a record of 42-36-4 will have received 88 points (84 points for wins and an additional 4 points for overtime losses). The team variable was included to capture the effect of the rest of the team. According to a study done by Claude Vincent & Byron Eastman, "Determinants of Pay in the NHL: A Quantile Regression Approach," team performance effects overall individual

player performance[6]. Similarly, according to Roger Blair in his "Sports Economics" textbook, a player will have a higher MRP_L if accompanied by similarly situated and talented athletes.[7] In terms of marginal product, a player with a high marginal product will be valued more by a team with an already high level of talent. Adding more talent will allow more of the marginal product to be utilized. On a lower skilled team, some of this additional marginal product may not be realized. This comes back to the team aspect of hockey; even Wayne Gretzky coming off one of his strongest seasons, scoring 192 points couldn't defeat the combined talent of the New York Islanders dynasty in the 1982-83 Stanley Cup Finals. This concept of team quality makes sense intuitively as well; a team comprised of highly skilled players will most likely perform better than a team that has one elite player who is surrounded by a mediocre level of talent. From 1980-1983, the New York Islanders won the Stanley Cup four times in a row, a feat that hasn't been bested since. The combined talent of Mike Bossy, Denis Potvin, Bryan Trottier, and John Tonelli were the reasons for the Islander's phenomenal success during their Cup streak. It follows that a player's MRP_L will increase as the average talent level for the team increases.

The four previous variables were used to measure a player's marginal product, and make up only half of the wage equation. Owners also factor in the additional revenues likely to be generated by signing a particular player as well. This is the marginal revenue factor. Usually, this manifests itself in the sale of official licensed gear with that player's name on it, like jerseys, but also includes a calculation of how many additional fans will attend home games to see that player perform. This distinction is important because in considering the market value added by a certain player, or his MRP_L, fan preference is the main determinant of the marginal revenue generated by that player because it is likely correlated with willingness to pay. The All-Star

variable is included to capture fan preference for a player or the effect of additional revenue a player might add to a team. In turn, if a player is preferred more by the fans, he holds more attraction for team owners because it will lead to higher ticket sales. In addition, teams will pay a player more if they believe that by hiring him, they not only will have better success on the ice, but they can also sell more licensed merchandise.[8] The All-Star variable has this unique characteristic because fans directly select players to perform in the All-Star game through a voting ballot, making this variable appropriately related to fan preference.

Finally, the offense/defense variable seeks to capture the inherent differences in playing styles and expectations of offensive and defensive players. An offensive player will score more than an equivalent defensive player, *ceteris paribus*, simply because of positioning and team role differences. The addition of this dummy allows more meaningful comparisons between the two positions. The forwards and defensemen were not regressed separately because the focus of this study is the difference between restricted and unrestricted free agents. While there is a difference between forward and defensive salaries, the dummy variable will accurately capture any relevant differences for a meaningful comparison of the two positions. Putting this all together the OLS estimated regression will take the following form:

$$\text{Log}_{\mathbf{y}}\mathbf{salary} = \boldsymbol{\beta_0} + \log \boldsymbol{\beta_1}\mathbf{goals} + \log \boldsymbol{\beta_2}\mathbf{assists} + \log \boldsymbol{\beta_3}\mathbf{plusminus} + \boldsymbol{\beta_4}\mathbf{career} + \boldsymbol{\beta_5}\mathbf{team} + \boldsymbol{\beta_6}\mathbf{allstar} + \boldsymbol{\beta_7}\mathbf{offdef} + \mu_i$$

Relating back to a the standard wage equation, many studies take the wage equation and transformed it into:

$$\log w = \log MP_L \times \log MR$$

Similarly, my equation to estimate the relationship between salary and performance indicators will use the same theory. Logging the dependent and independent variables allows for comparisons of elasticity, which makes results easier to compare.

Table 1 provides descriptive statistics for each of the variables included in this equation, as well as the expected sign and any transformations made to the variable. Variable descriptions are also included to provide an easy glance at what each encompasses.

Table 1. Variable descriptions, expected signs and descriptor statistics

Variable	Description	Expected Sign	Joint	Unrestricted	Restricted
$\log_y$salary	Log of Player salary ($ millions)	+	$\mu = 2.21$	$\mu = 2.70$	$\mu = 0.96$
			$\sigma = 1.9864$	$\sigma = 2.1160$	$\sigma = 0.5051$
log $\beta_1$goals	Log of goals scored by player in 2011-2012 season	+	$\mu = 9.13$	$\mu = 10.09$	$\mu = 6.44$
			$\sigma = 9.2368$	$\sigma = 9.8974$	$\sigma = 6.4153$
log $\beta_2$assists	Log of assists tallied by player in 2011-2012 season	+	$\mu = 15.60$	$\mu = 17.09$	$\mu = 11.37$
			$\sigma = 12.6180$	$\sigma = 12.9945$	$\sigma = 10.3432$
log $\beta_3$plusminus	Log of aggregate plus/minus rating, adjusted by 35 so lowest value = 1	+	$\mu = 34.69$	$\mu = 34.79$	$\mu = 34.33$
			$\sigma = 10.2760$	$\sigma = 10.7748$	$\sigma = 8.7146$
$\beta_4$career	Total number of games played per player throughout career, current for 2011-2012 season	+	$\mu = 380.27$	$\mu = 476.76$	$\mu = 113.95$
			$\sigma = 298.1644$	$\sigma = 289.0975$	$\sigma = 84.8254$
$\beta_5$team	Total number of points earned by team in 2011-2012 season	+	$\mu = 92.17$	$\mu = 92.51$	$\mu = 91.14$
			$\sigma = 11.5034$	$\sigma = 11.3635$	$\sigma = 11.8205$
$\beta_6$allstar	Total number of All-Star appearances by player, current for 2012 All-Star Game	+	$\mu = 0.36$	$\mu = 0.49$	$\mu = 0.03$
			$\sigma = 1.1830$	$\sigma = 1.3560$	$\sigma = .1916$
$\beta_7$offdef	Dummy variable; 1 = forward player 0 = defensive player	+	Joint Offensive Average Salary = $2.21 million	vs.	Joint Defensive Average Salary = $2.31 million

Note: μ signifies the statistical average of the variable for the designated group, and σ signifies the standard deviation of the variable for the designated group.

Based upon all the information collected and the difference between restricted and unrestricted free agents, one final issue merits some discussion. The presence of the CBA suggests that salary determination for restricted and unrestricted agents may well be different. For restricted free agents it is likely that most, if not all, of the regressors will be unimportant or statistically insignificant. For the reasons outlined during the variable descriptions, most, if not all of the variables will be statistically significant for the unrestricted free agent, particularly the goals and career variables, which were shown to have the most significance in Vincent and Eastman's quantile regression approach.[9] First, I'll estimate the joint regression, and then I separate the sample with the same regression model. The joint regression may present some surprises in terms of what effect the mixing of the two different agents will have. Likely, since there are more unrestricted than restricted agents, the effect of the restricted agents will be muted in comparison to the effect of the unrestricted agents. The signs, as shown in the table, for goals, assists, plus/minus, career, All-Star, and team are all likely to be positive; the dummy variable offense/defense should be positive as well.

IV. Presentation of the Regression Analysis

Table 2 presents the results from my regression analysis. In column one, results from the joint regression are shown and in columns two and three the results of the unrestricted and restricted regressions are shown, respectively. Through comparing and contrasting the individual models for the unrestricted and restricted free agents with the results of the join regression, it will be more clear the effect that each group's bargaining rights has on the salary determination. The results for all three regressions are as follows in Table 2:

Table 2: OLS Estimates for Joint, Unrestricted and Restricted Regressions

	Regression Coefficients		
Variables	**Joint**	**Unrestricted**	**Restricted**
GOALS	0.18106**	0.23175**	-0.02650
	4.38	4.41	-0.58
ASSISTS	0.19660**	0.26263**	-0.04275
	4.68	4.93	-0.88
PLUSMINUS	0.03920	0.07247	0.00908
	0.63	1.05	0.11
CAREER	0.00125**	0.00098092**	0.00301**
	12.55	8.40	8.08
TEAM	0.00016419	0.00015119	0.00191
	0.08	0.06	0.86
ALLSTAR	0.05736	0.04705**	0.08303
	1.72	2.09	0.42
OFFDEF	-0.27765**	-0.39143**	-0.02771
	-4.94	-5.34	-0.54

Note: Parameter estimates are listed first, followed by the corresponding t-value. Parameter estimates are taken from the OLS regression results, and the corresponding t-values below the parameter estimates have been corrected for heteroscedasticity with White's standard errors included in the regression.

**Significant at 5 percent for a two-sided t-test

Joint Regression

Of the seven variables shown in the Table 1 there are four significant variables for the jointly regressed model shown in the first column: *goals, assists, career* and the dummy *offdef.* As expected, the sign on the variable estimate for *goals* was positive and significant at the 5 percent level. Both *salary* and *goals* were expressed as natural logs, so they are elasticities meaning that a percentage change in one will correspond to a percentage change in another. For example, the parameter estimate for goals was 0.18106, meaning that a 1 percent increase in goals will lead to a .18106 percent increase in salary. For the average player in the National Hockey League making $2.26 million and scoring nine goals, an increase of one goal would be

an increase of 11.1 percent and lead to a 2 percent increase in salary, or an additional $45,200 for the average player.

For the variable *assists* the parameter estimate was found to be positive as well. Shown to be 0.19960, it is significant at the 5 percent level. This means for the average player in the NHL making $2.26 million and tallying sixteen assists, an increase of one assist would be an increase of 6.25 percent, corresponding to a 1.25 percent increase in salary, or an additional $28,250.

The *career* variable was also significant at the 5 percent level, and positively affects salary. The parameter estimate for this variable isn't logged, so an increase of one game will lead to a percentage increase in salary. The parameter estimate is much smaller than the other parameter estimates found for the statistically significant variables, and this is due to the high number of games played by many NHL players during their career. The OLS estimate for the parameter estimate for *career* is .00125; meaning one additional game played will only lead to a .125 percent increase in salary. For the average player, this means one more game translates into an additional $2,825. This may seem paltry, but when spread out over one whole season of 82 games, this converts into an additional $231,650. Five seasons means an additional $1,158,250, and ten seasons will net an additional $2,316,500, more than doubling the current average player salary. Considering many players stay in the NHL from 15 to 20 years, it is not unlikely that player salary could double twice, simply due to the effect that career experience has on their salary.

Finally, the *offdef* variable was significant. This variable was representative of forwards when equal to one, and defensemen when equal to zero. Because the parameter estimate is negative, this means that on average defensemen get paid more than forwards. This confirms our findings from the mean descriptive variable for the joint regression. The average forward salary for the sample was found to be $2.21 million, and the average defensive salary was $2.31 million. The parameter estimate was found to be -0.27765, so on average a defensemen will earn 27.765 percent more than their offensive teammates, *ceteris paribus*. The results from this variable were somewhat surprising. The predicted sign on the *offdef* variable was thought to be positive. Conventional wisdom would put forwards, or those represented by a one in the dummy data, as those with higher salaries. After all, the most lucrative contracts, like Ilya Kovalchuk's 17-year, $102 million contract with the New Jersey Devils, are usually given to forwards[10]. While forwards may have the highest paying contracts, it is entirely possible that they also earn the lowest as well. According to Forbes and CapGeek, for the 2011-2012 NHL season, there were a total of 297 defensemen on payroll, and 597 forwards. Not all of these players made appearances in the NHL, but they were paid as NHL players either way. The average defensive salary according to this data was $2.31 million, while forwards averaged $2.21 million.[11]

For the joint regression, three variables were found to be statistically insignificant. The variables *plusminus, team* and *allstar* were all found to be insignificant. One explanation for *plusminus* may be that there is a complicated story behind its insignificance. While there is logic behind measuring a player's defensive capabilities as measure of his salary, this is easily the most elusive of characteristics to empirically measure. What "talent" that may be readily

apparent to the trained eye of a scout does not translate well onto paper. Often, as Ashman and Lambrinos discuss in their arbitration study, "the best defensive players are usually on the ice when the opposing team has its best offensive players on the ice".[12] In other words, the "best defensive" players often have the most difficult job, making any corresponding statistical analysis difficult, because when compared to other defensemen, the assumption of *ceteris paribus* cannot be held; the situations each have different circumstances, which can presumably lead to different statistical results. Looked at the other way around, the "weakest" defensive players might often be paired up against the opposing team's fourth line "grinders", making their job "easier." This might explain the discrepancies in statistical reporting, and why it is so difficult to make broad comparisons between defensive abilities and salary. The plus/minus statistic is also tricky because of its tendency to not only include defensive ability, but offensive as well.

In addition, there is productivity to be measured on both sides of the coin; on one side, a highly productive defensemen could be described as someone who scores goals and assists frequently. They could also be described as someone who can consistently prevent the other team from scoring, and when described in terms of the other team's productivity, this could be a measure of his "counter-productivity." The difficulty with plus/minus is again that it measures both aspects, and does not discriminate or register differences between the two factors; they are simply aggregated into one statistic. As both Ashman and Lambrinos and Vincent and Eastman have shown, the significance of the plus/minus statistic may be touted by statistics aficionados, but what regression after regression has shown is that it is simply not enough by itself to measure defensive, or offensive, ability and hence marginal productivity.

The other insignificant variable, *team*, could be explained through a number of reasons. Initially included as a measure of team quality, it may not be tied close enough to individual talent on the team. After all, hockey is a team game, and teams have progressed deep into the playoffs without having top-goal scorers or players ranked among the highest performing in the league. For example, when Boston won the Stanley Cup in 2011, their highest performing player Milan Lucic was ranked fortieth in the league in points, at a moderate 62 for the season. Daniel Sedin, on the other hand, who played for the Cup rival Vancouver Canucks, was first in the league with 104 points, but it didn't translate into a Cup win for Vancouver. Measuring the "quality" of the team that each player plays for is difficult for this reason.

The last insignificant variable for the joint regression was *allstar*. This variable summed the total number of times each player was elected to appear in the annual NHL All-Star competition by the fans. Included as a measure of a player's marginal revenue, it was found to be insignificant. While there were certainly players included in the regression that were elected to many separate All-Star appearances, there were also plenty that had never been voted in at all. Considering only about 30 players are chosen each year to play for the All-Star teams, it's not incomprehensible to assume that many of the players included in this 710 player study were not ever selected to perform in an All-Star competition, especially when considering restricted free agents and rookies were regressed in this joint equation as well.

Unrestricted Free Agent Regression

In the second column of table two, the results of the unrestricted free agents are presented. The reasons for separating the two regressions, and the two groups of players, will

be readily apparent with the results of the unrestricted free agents compared to those of the restricted. The unrestricted free agent regression was very similar to the joint regression, with one major difference separating the two; the significance of the *allstar* variable. The *allstar* variable became significant when regressing only those players that qualified for unrestricted free agency – or players that most likely performed better on average than their restricted counterparts, as well as having more experience in the league. The parameter estimate for the *allstar* variable was .04705, meaning an additional All-Star appearance resulted in a 4.705 percent increase in salary, but for the average player making $2.26 million, this is only an additional $106,333. Not a small amount of money, but very small compared to the average salary. The whole effect felt by an All-Star appearance is unlikely to show up in a regression just measuring salary compensation, though.

An alternative explanation of compensation might be more appropriate in describing this effect. While it is entirely plausible to assume a player may command a higher salary having been elected to an All-Star game, that election is more commonly rewarded with a bonus clause. Performance bonuses are written into most contracts. According to the CBA of 2005[13], performance bonuses may be written into contracts for championships (Stanley Cup), individual bonuses (highest goals scored, highest plus/minus, etc.), or league awards, including being elected to the 1st or 2nd All-Star team. So while there is a correlation between All-Star appearances and salary, a more common reward for All-Star elections are the bonuses for performance stipulations, which include All-Star appearances.

The other variables, *goals, assists, career* and *offdef* all remained significant in the unrestricted free agent regression as well as the joint regression. The parameter estimate for *goals* moved from 0.18106 to 0.23175, meaning that goals were more significant, and had a higher effect on salary for unrestricted agents than when players were all regressed together. Considering the limits placed on restricted free agents, this is consistent with the original hypothesis about the effect restricted free agency would have on salary determination. The variable *assists* tells the same story, with its parameter estimate rising from 0.19660 to 0.26263; increases in assists were worth more in salary increase than they were for the joint regression. Interestingly, the *career* variable moved in the opposite direction. Moving from the joint regression to the unrestricted regression, the parameter estimate decreased from 0.00125 to 0.00098092. This means that an increase of one game was worth less in terms of an increase in salary for unrestricted agents than it would be for the joint regression of both unrestricted and restricted free agents. Considering that when moving from the joint regression to the restricted regression, the parameter estimate increased from 0.00125 to 0.00301, there is a story behind this. Given most restricted free agents are younger players, it makes sense that one more career game would have more of an effect. For example, take the average number of games played by a restricted free agent for this study; it's only 114 games. For the average unrestricted free agent 477 games have been played. An increase of one game to a restricted agent is on average an increase of 0.877 percent. An increase of one game to an unrestricted agent is on average only an increase of 0.210 percent; that's a 317 percent difference between the two. This also makes sense when considering there are most likely diminishing returns to career games going on here. To some extent, one more career game will lead to less and less

returns to the player. In addition, at some point the player will start to grow old, and his performance cannot stay at the same levels he maintained when he was younger. Going even further, eventually the player will be too old to play, and he will have to retire. Simply stated, increasing career games are worth more to younger players than they are to older players, and the regression results support this hypothesis.

The last significant variable to change was the *offdef* dummy variable. Moving from the joint regression to the unrestricted regression, this variable decreased from -0.27765 to -0.39143. This means that on average, defensemen earned *even more* than their offensive counterparts; 39.143 percent more in fact. This effect is justified when considering the characteristics of each data set. For the joint regression, restricted agents are still included, meaning their restrictions on contracts and salaries are also included. When these restrictions are removed, the effect that being a defensemen has on corresponding salary is even clearer. Defensemen make on average almost 40 percent more when unrestricted and are free to bargain for their salary; this is quite a significant difference.

Restricted Free Agent Regression

In the third column are the results of the restricted free agency regression. The restricted free agent regression performed much as expected. The only significant variable was *career*. Even in the restricted market this makes sense. Players are eligible for pay increases at the expiration of their current contract. Most rookie contracts are only signed for a few years, and before players reach the age/experience requirement for unrestricted free agency, most have signed at least one or two contracts. While the increases in pay for their contract after

each expiration is clearly defined in the 2005 Collective Bargaining Agreement, the longer a player stays in the league, the higher his pay will be even if the increases are more modest, as they are with restricted agents. As mentioned before, the parameter estimate for the restricted free agent *career* variable is 0.00301, meaning that an increase of one game will lead to an increase in salary by 0.301 percent. For the average restricted agent making $960,000, this corresponds to an additional $2,890. This value is greater than the value of the joint regression increase, which was $2,825. This is only a difference of $65 but keep in mind the average salary for the joint regression was $2.26 million. If the same value were used for the restricted free agent regression, the effect of an additional game on salary would increase to $6,803, almost three times as much value. This clearly illustrates the value of career games to restricted agents versus the value of career games to unrestricted agents. When that value of $6,803 is extrapolated out, a restricted agent could expect to earn an additional $557,831 per season, $2,789,066 over five seasons, and an additional $5,578,132 over ten seasons. That is quite a difference.

The other variables *goals, assists, plusminus, team, allstar,* and *offdef* are insignificant, which is expected because of the manner of restricted free agency. Teams only have to make a qualifying offer to keep exclusive rights to bargaining with that player. As outlined before, these qualifying offers do not really require the team to give up much, but effectively restrain the agent from making any roster moves. Pay is much more dependent on these bargaining agreements than they are on performance indicators, so it makes sense that the performance indicator variables are insignificant.

V. Regression Comparison

Comparing the results of the three regressions, several differences are apparent, and the reasons for separating restricted and unrestricted agents are much clearer. While performance indicators are significant in the joint regression and for unrestricted free agents, they are not for restricted free agents. Career experience is significant in both groups, and most likely for different reasons. High career games among unrestricted free agents readily translate into experience. Higher career games among restricted free agents is likely correlated because more games mean more contract renegotiations, even if they are limited. With each renegotiation, salary must increase in order to achieve a qualifying offer, and is likely the reason for the correlation among the restricted free agents.

The other major difference between the restricted and unrestricted regressions is the significance of the *allstar* variable. This variable measures the number of total All-Star appearances by each player and is intended to capture fan preference and corresponding marginal revenue of the player. It is statistically significant for the unrestricted free agents, and insignificant for the restricted free agents. This makes sense when considering the average age of All-Star players is 30 years old[14] higher than the upper bound of 27 years for restricted free agents. While there were some restricted free agents who had already been elected to their first All-Star game, none had appeared more than once. These numbers paled in comparison to the number of appearances by unrestricted free agents. Nicklas Lidstrom was elected to twelve All-Star appearances and veteran Teemu Selanne has ten under his belt. Interestingly, when the unrestricted regression is compared to the joint regression, the only difference in significance

between the joint regression and the unrestricted free agents is the *allstar* variable. There are far more unrestricted free agents in the league than restricted – 519 unrestricted compared to 187 restricted for this regression. What is interesting is that those 187 restricted agents had enough of an effect to change the *allstar* variable to be insignificant when the league's players are regressed as a whole.

The restricted free agent regression also differed greatly from both the joint and unrestricted regression in terms of performance indicators. Not a single performance indicator included was shown to significantly affect salary. This is an important finding because it shows the importance of separating the two groups of agents, and the differences between unrestricted and restricted free agents. The variables *goals, assists, allstar,* and the dummy *offdef* were shown to be insignificant. While there is insignificance of these variables for a restricted free agent this insignificance only applies to the period before unrestricted free agency is reached. League restriction on contract values for incoming rookies artificially lowers contract values from the normal market determined value. This effect can be clearly illustrated by the first unrestricted free agency contract signed following a period of restricted contract negotiations. For example, take Sidney Crosby, who was runner-up in scoring his first season in the NHL and in his second season he won the Art Ross trophy for leading the league in scoring. His salary for the first three years in the NHL was $850,000, for a combined value of $2.55 million. Considering this is only $200,000 above the minimum rookie amount, it is safe to assume that performance was not factored into his contract at this time, and couldn't be because of league contract restrictions. His production was above every other player except one his first season, and was above every single player his second season. His third season he

only performed slightly worse; he was ranked third in production. His fourth year in the league, his contract was renegotiated to reflect his performance; he resigned with the Pittsburgh Penguins for $9 million a year, tied for highest salary awarded to a forward with Alexander Ovechkin. This type of contract would not have been offered without his stellar performance in previous years, and it is evident because his production did not change significantly between his third and fourth years. The nature of contracts endows them with a built in time-delay; contracts are multi-year deals, and with few exceptions, are not renegotiated until the current contract expires. This characteristic makes restricted free agent contracts particularly vulnerable to time delay. Exceptional performance is not rewarded the following *season*, but rather in the next *contract negotiation*. This explains why every variable except *career* were insignificant in the restricted agent regression.

VI. Conclusions

These results illustrate that there are remarkable similarities between sports labor markets and normal labor markets. In regular labor markets, wages are a function of experience and education for the most part, among other things. The same can be said about the hockey labor market in the NHL. What's different is the trove of data available for the productivity for each individual player. Because of this unique characteristic, salary is linked to experience, but also performance indicators, as well as measures of marginal revenue. As show by the unrestricted agent regression, there is a positive, significant relationship between goals, assists, career games, and All-Star appearances. The significant difference between this study and previous studies is the separation of unrestricted agents and restricted agents. The conditions

outlined in the 2005 CBA for restricted agents severely limits the salary negotiations for those players. There are important and divisive differences between the two groups. Previous studies have not separated the two, even though they recognize forwards and defensemen are two different groups. Just as there are fundamental differences in the responsibilities of the two positions, there exist the same rifts between unrestricted and restricted agents. By separating the two, the effects of performance indicators were revealed. For a 1 percent change in each goals and assists, corresponding salary changes increase from .18 percent to .23 percent, and .19 percent to .26 percent respectively, moving from a joint regression to regressing only unrestricted agents. While this may not seem like much, these elasticities are clearly different for the two groups. Only one variable was significant for restricted agents; five were significant for unrestricted agents, and this number dropped to four when the two groups were regressed jointly. Failing to recognize this difference is akin to considering forwards and defensemen the same. Price floors and ceilings have a much greater effect on the salaries of restricted agents than they do for unrestricted agents. The important result from this study is the realization of this difference. Subsequent studies should realize this difference for more meaningful results. The results from all three regressions clearly illustrate this difference. Performance indicator variables, or measures of a player's marginal product, are insignificant for restricted agents, at least until the *next* renegotiated unrestricted contract, as shown in the case of Sidney Crosby. Experience variables, like *career*, are shown to be *more* significant for restricted agents, or less experienced players, than they are for unrestricted agents, or more experienced players. This clearly illustrates the economic concept of diminishing returns, specifically diminishing returns to career games. There is only so much experience one can attain before each corresponding

increase in games leads to less and less of an increase in salary, and possibly even becomes negative. As shown above, increases in one career game are worth much more to restricted agents than they are to unrestricted agents, clearly supporting the theory of diminishing returns to experience.

While the measure included to assess the scope of the effect a player has on marginal revenue was only significant for unrestricted agents, this makes sense as well. Most restricted agents are new to the league, and haven't had time to establish their name among any fan bases. Fans don't vote for players they don't know. As such, a rookie's marginal revenue will be comparatively low when juxtaposed to an unrestricted agent who has had many years experience in the league, and years to promote his name and his playing style. Fans love a player they can cheer for, but many fans simply just don't know enough about rookies or newer players to support them over tried and true favorites. In this case, experience wins out over youth.

Perhaps as important are the results of the plus/minus and team point variables – those that were insignificant when regressed together and separately for the unrestricted agents. Both were found to be insignificant. Both were included to capture perfectly valid and important characteristics in not only the determination of salary, but also what affects the marginal revenue product of labor. Defensive ability is obviously important in a game where preventing goals scored is as critical as scoring them. What it revealed is the insufficiency of the plus/minus statistic to achieve this end. In Vincent and Eastman's quantile approach, height and weight were found to be insignificant. In their study, plus/minus was insignificant for forwards,

and only significant for defensemen in the tenth percentile.[15] The NHL clearly suffers from a shortage of defensive statistics, creating significant difficulties in measuring the defensive abilities not only for defensemen, but for forwards as well.

Team quality is also an important determinant of a player's salary. Blair argues that the marginal revenue of player talent will be higher in big market towns (New York) than the corresponding marginal revenue schedule in small market towns (Edmonton). The same principle applies to the marginal product of labor for player talent. The marginal product of labor of a certain player will be enhanced by higher quality teammates. Take Rick Nash for example; he has played most of his career with the Columbus Blue Jackets, who have frequently landed at the bottom of the standings and who, currently, are the only team to have never made the playoffs. Rick Nash was his team's leading scorer throughout his tenure in Columbus, always by a significant margin. His recent trade to the New York Rangers represents a significant change in team quality. The Rangers are not only frequent Stanley Cup contenders, their goalie Henrik Lundqvist is considered one of the best in the league; he has been nominated for the Vezina Trophy four times, and won it most recently in 2012. Unfortunately, Nash's effect on the Rangers remains to be seen pending the current NHL lockout, but the increased quality of talent and Nash's acquisition by New York stands to enhance not only Nash's marginal product of labor, but also his teammates' as well.[16] The variable used in this regression, team points garnered for the current season, is insufficient to capture this phenomenon.

While this study has recognized differences between not only restricted and unrestricted free agents, but also between forwards and defensemen, the question could be asked, "Why not separate forwards and defensemen into separate regressions as well?" While this is a valid question, the answer is equally valid. The main focus of the study was to examine the differences between restricted and unrestricted free agents as stipulated by the CBA. For this reason, restricted and unrestricted agents were regressed separately, along with a "control" regression that regressed both groups together, the joint regression. Separating the forwards and defensemen was unnecessary; there is plenty of economic literature that supports the conclusions that the two groups are different, including the two studies included in the literature review. Knowing this separating them through the use of a dummy variable is simple enough to keep only three regressions, but complete enough to fully treat each group as a distinct data set.

This unique regression has taken characteristics commonplace for salary determination not only in the National Hockey League, but in normal labor markets as well. One important caveat separates this from others; the separation of restricted and unrestricted free agents as well as forwards and defensemen. As expected, restricted and unrestricted agents have differences in salary/wage receipts; differences that are written right into the labor agreement signed in 2005. Just as forwards and defensemen have different roles that are enumerated in the NHL rulebook, similarly restricted and unrestricted agents differ in wage determinations. The real surprise came from the differences between forwards and defensemen; despite the most lucrative contracts going to forwards, it is the defensemen who earn more than their offensive counterparts. These expectations and surprises were illustrated well in the OLS

results, and support the notion that both groups have inherent differences that separate them; restricted and unrestricted, forwards and defensemen.

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